DESCARTESITES: MISSING(?) PRISTINE ROCKS. J. Longhi , Lamont-Doherty Earth Observatory, Palisades, NY 10964 (longhi@lamont.ldeo.columbia.edu)

A thermal divide on the plagioclase+pyroxene liquidus surface is stable at modest crustal pressures (3-4 kb) in terrestrial magmas and inhibits silica enrichment in liquids residual to anorthosites [1]. The same divide is predictably stable to lower pressures (1-2 kb) in lunar compositions because of lower alkalies and may play a vital role in explaining the absence of granitoids ("descartesites" = anhydrous trondjhemites) residual to the formation of lunar ferroan anorthosites (FAN).

Results of some new modeling of liquids parental to ferroan anorthosites are shown in Figs. 1 and 2. The calculations incorporate new low-pressure experimental data, which show that the algorithm developed by Drake [2] slightly overestimates the Ab content of anorthitic plagioclase — compare open squares (algorithm) with filled squares (experimental plagioclase) in Fig. 1. Dividing the Ab content calculated from eq. 8 of [2] by the term $(1. +(1.-NAB -NOR)*(Fe')^2)$ produces a satisfactory fit. NAB an NOR are the Ab and Or fractions of the normative feldspar; $Fe' = $ molar $FeO/(FeO+MgO)$.

Fig. 1 illustrates the mineral composition paths generated by fractional crystallization of a model FAN parent liquid [3] at 2 pressures, 0 and 3 kb. Although there is little apparent difference in plag composition and Mg', very different rocks form by accumulation. Ol is present everywhere along the 3 kb track, but is absent where the 0 kb track passes through the field of FAN mineral compositions. More importantly, though, there is a long interval where plag, aug, ol/pig, and a silica mineral cocrystallize at low-pressure, but not at 3 kb. The calculated fractional crystallization paths of the corresponding liquids are shown in Fig.2 (filled squares = 0 kb; open circles = 3 kb; the letters *o, p, i* indicate the first appearances of ol (+plag), pig, and ilm, respectively; the last symbol in each set represents 98% crystallization). The 3 kb fractionation path is offset from the 0 kb path because of the pressure-induced shift in liquidus boundaries, especially ol + pig. Note in particular that the liquid where ol, pig, and plag coexist shifts from the Qtz side of the Opx-Pl join at low pressure to the Ol side at 3 kb. In doing so, this pseudo-invariant point changes from peritectic (ol reacts with liquid) to a eutectic and at the same time a coplanarity between liquid and coexisting plag and pyx is exposed. At modest pressures this coplanarity is close to the Opx-Pl join,

but at mantle pressures, increasing Al-substitution in pyroxene shifts the pyroxene composition toward lower Qtz component and, hence, the coplanarity shifts away from the join. Although this transition is compositionally dependent, it occurs at ~ 1 kb for this parental liquid composition. At 0 kb the silica-bearing cumulates constitute approximately 20 vol% of the sequence; and if efficient separation of mafic and felsic minerals were to have taken place the result would have been an anorthositic rock (An_{90-95}) with 10-15 % silica mineral ("descartesites"). Conversely, at 3 kb olivine forms only about 10 -15 % of the crystallized mafic component. Thus some apparently ol-free anorthosites might be the result of limited sampling of rocks crystallized from ol-saturated magmas.

The absence of siliceous anorthosites is readily explicable in terms of a well behaved magma ocean (MO): no primary silica is to be expected as long as the floating crust reached a thickness of ~ 20 km before the MO became silica saturated. This stipulation also means, however, that the array of mineral compositions in Fig.1 has stratigraphic significance with the anorthosites having the minerals with the highest Mg' having formed first and closest to the surface. So far pyroxene exsolution barometry has placed 2 similar ferroan anorthosites at cooling depths of 14 and 21 km [4]. More barometry is needed on samples at both the high- and low-Mg' ends of the FAN array to establish any stratigraphic significance. The presence of olivine-bearing "sodic" ferroan anorthosites [5] is consistent with either a different parent magma or a similar parent magma crystallizing at higher pressure. In either case, a simple MO scenario does not apply, but crystallization at pressures $\geq$ 1 kb remain essential to avoiding formation of descartesites.

REFERENCES

[1] Longhi J., Vander Auwera J., and Fram M.S. (1996) *EOS,* AGU Fall Meeting. [2] Drake M.J. (1976) *Geochim. Cosmochim. Acta, 40,* 457-465. [3] Longhi, J. (1989) *Lunar and Planetary Science XX*, pp. 584-585. [4] McCallum I.S. and O'Brien H.E. (1996) *Am. Mineral. , 81,* 1166-1175. [5] James, O.B., M. M. Lindstrom, and M. K. Flohr (1988) *Proc. Lunar Planet. Sci. Conf. 19th,* p. 219-243.

DESCARTESITES: MISSING(?) PRISTINE ROCKS: J. Longhi

Fig. 1 Calculated mineral compositions for 0 and 3 kb fractional crystallization of model FAN parent magma [3]. "*ol in*" etc. refer to 0 kb track only; silica-bearing cumulates represented by open pattern. 0 kb sequence: ol+plag; pig+plag; aug+pig+plag; sil+aug+pig+plag; ol+sil+aug+plag; ilm+ ol+sil+aug+plag (black line). 3 kb sequence: ol+plag;pig+ol+plag;aug+pig+ol+plag; ilm+aug+pig+ol+plag. Also comparison of experimental liquids (filled circles) and plag + ol (filled squares) with plag predicted by eq. 8 of [2] (open squares).
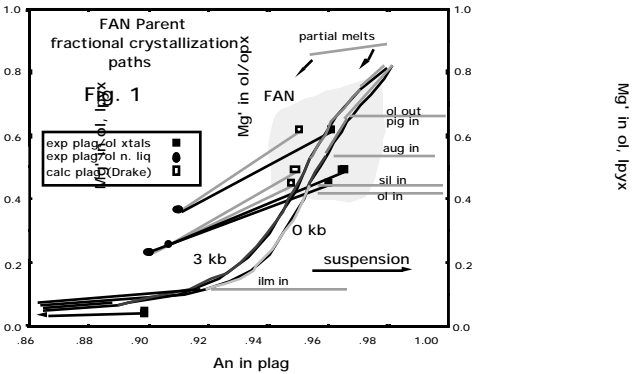

Fig. 2 Calculated liquid compositions for 0 and 3 kb fractional crystallization paths in Fig. 1. Projection from Wo component onto Ol-Pl-Qtz plane. Solid lines are 1 bar liquidus boundaries; heavy broken curves are 3 kb boundaries; both sets of liquidus boundaries appropriate to respective liquids saturated with ol+pig+plag.